Soil Temperature Protocol

Purpose

To measure near-surface soil temperature
To detect diurnal changes in soil temperature
To learn about the insulating capabilities of the soil

Overview

Soil Temperatures at 5 and 10 cm depths will be measured using a probe thermometer. Soil temperature is a function of climate, soil, soil moisture, depth and geographic setting. This protocol collects data to explore these interactions.

Time

10-15 minutes per measurement set
(6 probe measurements)

Level

All

Frequency

Weekly: three measurements each at 5 and 10 cm depths

Seasonally: one measurement each at 5 and 10 cm depths every 2 to 3 hours during the daytime on two consecutive days

Key Concepts

Soil is an insulating layer.
Soil temperature varies with depth, soil moisture, and air temperature.
Soil temperature varies less than air temperature.

Skills

Reading dial scales
Field *sampling*
Observing related phenomena
Graphing temperature cycles

Materials and Tools

Dial or Digital probe thermometer
12 cm finishing nail and hammer
A wooden block with 6 mm diameter hole through it
Calibration thermometer

Preparation

None

Prerequisites

None

Site Selection and Timing

Make measurements adjacent to your Soil Moisture Study Site, or if this is not possible, within 10 m of your Atmosphere Study Site. Study the figures of the star or transect sampling patterns described in the *Sampling Strategies* and *Site Layout* sections which illustrate acceptable sampling locations. If you are making these measurements at your Atmosphere Study Site, follow the sampling pattern and site layout for the Star Pattern.

1. Select a relatively flat sunny area.
2. Try to find an area with uniform characteristics across an area having a diameter of 5 m.
3. The ground should not be compacted but can be covered with litter or grass.
   - Make a note on the Data Work Sheet if it has rained in the past 24 hours.

When making measurements on consecutive days, try to make your readings on days with similar weather conditions and for soil conditions that are typical for the week you are making them. Try to make diurnal readings around the middle of March, June, September, and December.

Preparing for the Field

Your thermometer should be most sensitive to temperature changes about 2 cm from the tip because of the length of the temperature sensor inside the probe. To take measurements at 5 and 10 cm depths, the thermometer will have to be pushed 7 and 12 cm into the ground.

Drill a hole in a wooden block so that when the soil thermometer is pushed all the way into this hole 7 cm of your probe extends beyond the bottom of the block. This will help students maintain a uniform depth for the 5 cm depth measurements.

Get a nail that is the same length and diameter as your thermometer probe or cut a nail to this length.

Calibration:

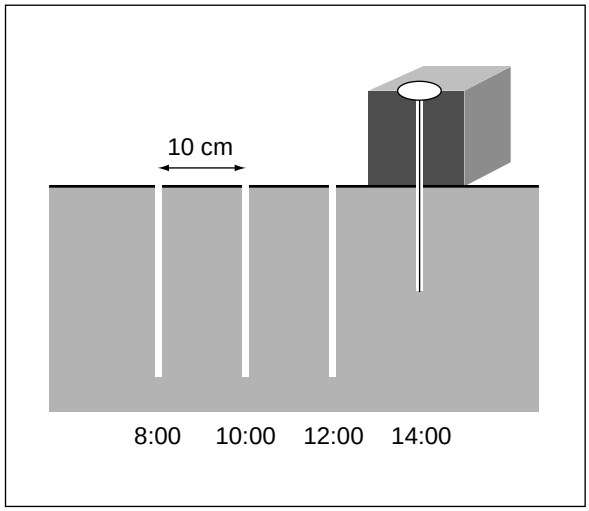
Check the accuracy of your probe every three months. This is particularly important if you are using more than one thermometer, as differences or biases between two thermometers will make your data impossible to interpret. Follow this calibration procedure:

1. Use the calibration thermometer from the Atmosphere Investigation as a calibration standard.
2. Place your thermometers in water at room temperature; record their temperature readings after 2 minutes.
3. There should be less than 2° C difference between your thermometer readings and the calibration thermometer.
4. Follow the manufacturer's directions to reset dial-type thermometers, if your differences are greater than this.

How to Measure Soil Temperature

1. **Make a pilot hole to 5 cm.** Insert the nail through your wood block and push it to 2 cm above the top of the block. If the ground is so hard you have to use a hammer, then complete the pilot hole to its full depth. Remove the nail using a twisting motion. If the ground cracks and bulges up as you remove the pilot nail, offset 25 cm and try again. Try to minimize the amount you disturb the soil.
2. **Insert the thermometer to 7 cm.** Insert the thermometer through your block. Gently push and twist the thermometer until the head is resting on the block. Do not force it as this will damage your instrument.
3. **Read the soil temperature at 5 cm.** Wait at least 2 minutes; read the thermometer. Wait another minute, and reread the thermometer. Repeat until consecutive readings are within 0.5 - 1.0° C of each other. Record this value on the Soil Temperature Data Work Sheet.
4. **Remove the thermometer and the block.** Use a twisting motion - try not to disturb the soil.
5. **Repeat steps 1-4 without the wood block.** Gently push and twist your thermometer fully into the ground using the same hole as before. Instead of depths of 5 and 7 cm, use depths of 10 and 12 cm, respectively.
6. Report your measurements to the GLOBE Student Data Server on the Soil Temperature Data Entry Sheet.

Figure SOIL-P-18: Soil Temperature: Layout of Diurnal Observations



Weekly Measurements

Take three sets of soil temperature measurements adjacent to your current soil moisture star pattern sampling location or next to your Atmospheric weather shelter at 5 and 10 cm depths. Complete these measurements within 1 hour of local solar noon and within a period of 20 minutes. Record your time to the nearest 10 minutes (e.g. if you take the 5 cm reading at XX:06, select the next 10 minute mark, XX:10, as your time of observation.

Diurnal/Seasonal Measurements

Take diurnal temperature measurements every three months, preferably during March, June, September, and December. Repeat the measurements every 2 to 3 hours on two consecutive days. Try to take at least 5 readings per day. Offset each new reading by at least 10 cm. See Figure SOIL-P-18. Read the current temperature at your Atmosphere Investigation Instrument Shelter and record it in your GLOBE Student Notebook each time you measure soil temperature.

Data Analysis and Presentation

Construct a table in your GLOBE Student Notebook similar to the one below for recording your results or use the Soil Temperature Data Work Sheet. Plot the data using Figure SOIL-P-20 as a guide.

Figure SOIL-P-19: Soil Temperatures Tucson, AZ, USA

	2/12/97			2/13/97		ND=no data
Local Time	5 cm	10 cm	Local Time	5 cm	10 cm	Air Temp
8:00	5.0	7.2	8:30	5.1	7.7	ND
10:00	9.5	9.1	10:30	12.0	9.4	ND
12:00	17.8	13.0	12:30	19.4	13.8	26.2
14:30	20.6	16.5	14:30	21.1	16.3	ND
17:00	16.8	16.3	17:00	16.7	16.3	ND
20:30	13.0	13.9	20:00	12.5	13.6	ND

Figure SOIL-P-20: Soil Temperatures